Please write clearly in block capitals.

Centre number | | | | | | Candidate number | | | | |

Surname _____

Forename(s) _____

Candidate signature _____
I declare this is my own work.

A-level
BIOLOGY

Paper 3

Monday 15 June 2020 Morning Time allowed: 2 hours

Materials
For this paper you must have:
- a ruler with millimetre measurements
- a scientific calculator.

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A**.
- Answer **one** question from **Section B**.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 78.

For Examiner's Use	
Question	Mark
1	
2	
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5	
6	
7	
TOTAL	

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Section A

Answer **all** questions in this section.

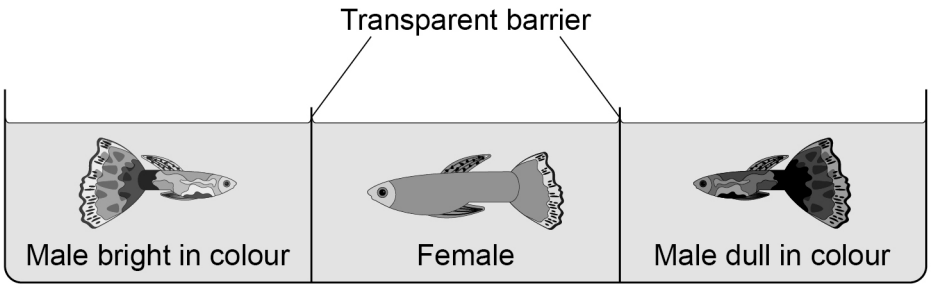
You are advised to spend no more than 1 hour and 15 minutes on this section.

0 1 Guppies are small fish. Female guppies are dull in colour. Male guppies can be bright or dull in colour.

Scientists investigated the effect of female brain size on choosing a mate. They used laboratory-bred female guppies with large brains and with small brains.

They set up a fish tank as shown in **Figure 1**.

Figure 1



They observed each female for 10 minutes and recorded which male they were attracted towards. They repeated this with 45 large-brained females and 45 small-brained females.

0 1 . 1 Suggest **three** possible limitations of this investigation.

[3 marks]

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Guppies with large brains are better at identifying predators.

The scientists found that **only** female guppies with large brains were attracted to male guppies bright in colour.

0 1 . 2 Suggest and explain the advantage of this behaviour to the population of guppies.

[3 marks]

0 1 . 3 Describe how the behaviour of female guppies could result in sympatric speciation.

[3 marks]

9

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0 2 In northern India, there is a conflict of interests between farmers of livestock (eg cows) and people trying to conserve ibex (a type of wild goat).

When livestock are given extra food, their populations can grow too large and compete with ibex.

0 2 . 1 Name the type of competition between livestock and ibex.

[1 mark]

_____

Livestock will outcompete ibex if they:

- are in the same habitat
- eat a similar diet.

Scientists investigated this conflict of interests.

Table 1 summarises some of the scientists' findings.

Table 1

Type of livestock	Difference between livestock food and ibex food*	Difference between livestock habitat and ibex habitat*
Cow	1.0	1.5
Horse	0.5	0.0
Yak	0.0	2.0

* A score of 0.0 indicates that the food or habitat is the same.

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0 2 . 2 There must be a balance between the need for conservation of the ibex and the need for farmers to keep livestock.

Using **all** the information, suggest and explain **three** actions that the farmers could take to achieve this balance.

[3 marks]

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Turn over for the next question

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0 3 In Europe, viruses have infected a large number of frogs of different species. The viruses are closely related and all belong to the Ranavirus group.

Previously, the viruses infected only one species of frog.

0 3 . 1 Suggest and explain how the viruses became able to infect other species of frog.

[2 marks]

0 3 . 2 Name **two** techniques the scientists may have used when analysing viral DNA to determine that the viruses were closely related.

[1 mark]

1

2

0 3 . 3 Determining the genome of the viruses could allow scientists to develop a vaccine.

Explain how.

[2 marks]

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0 3 . 4 Describe how the B lymphocytes of a frog would respond to vaccination against Ranavirus.

You can assume that the B lymphocytes of a frog respond in the same way as B lymphocytes of a human.

Do **not** include details of the cellular response in your answer.

[3 marks]

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Turn over for the next question

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0 4 **Table 2** shows information about two types of medicine.

Table 2

Name of medicine	Mass of medicine in one tablet / mg	Maximum dose of medicine an adult is allowed	Mass of sodium in one tablet / g
Aspirin	300	0.6 g every 4 hours	0.15
Paracetamol	500	1.0 g every 6 hours	0.43

0 4 . 1 A journalist studied the data in **Table 2**. She made the following suggestion.

'If an adult takes the maximum number of tablets allowed for **either** of the medicines, then the person would have more than the RDA of sodium.'

The RDA (recommended daily allowance) of sodium for an adult human is 2.4 g per day.

Is the journalist's statement true for **both** of the medicines in **Table 2**?

Use suitable calculations to support your answer.

Show your working.

[2 marks]

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Doctors investigated the link between high sodium concentrations in medicines and hypertension (high blood pressure).

They analysed medical records of patients. 1 292 337 of these patients had taken medicines containing high sodium concentrations. Each of these patients was paired with a patient from a control group.

0 4 . 2 Give **two** factors that should have been the same for each pair of patients and **one** factor that should have been different.

[2 marks]

Same factor 1 _____

Same factor 2 _____

Different factor _____

0 4 . 3 Doctors found:

- 4.73% of the patients who had taken medicines containing high sodium concentrations suffered from hypertension
- there were 7.18 times fewer control patients with hypertension.

Calculate how many of the control patients had hypertension.

Show your working.

[2 marks]

Answer _____ patients

Question 4 continues on the next page

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0 4 . 4 A high concentration of sodium in the blood can affect blood volume and cause hypertension.

Use your knowledge of water potential to suggest how high sodium concentrations in the medicines taken could affect blood volume.

[3 marks]

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0 5 . 1 In the UK in 2016, there were 525 048 deaths. Cancer caused 30.4% of all deaths. Throat cancer caused 5% of all deaths from cancer.

Calculate the mean number of people who died of throat cancer per month in 2016.

Show your working.

[2 marks]

Answer _____ people per month

Increased methylation of the promoter region of a tumour suppressor gene causes one type of human throat cancer.

In this type of throat cancer, cancer cells are able to pass on the increased methylation to daughter cells. The methylation is caused by an enzyme called DNMT.

Scientists have found that a chemical in green tea, called EGCG, is a competitive inhibitor of DNMT. EGCG enables daughter cells to produce messenger RNA (mRNA) from the tumour suppressor gene.

0 5 . 2 Suggest how EGCG allows the production of mRNA in daughter cells.

[3 marks]

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Question 5 continues on the next page

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The scientists investigated the effect of different amounts of EGCG on the growth rate of the throat cancer cells grown *in vitro*. Their results are shown in **Figure 2**.

Figure 2

This figure has been removed due to third-party copyright restrictions.

0 5 . 3 A reporter who reviewed all of this work concluded that drinking green tea could be a cure for cancer.

Suggest **three** reasons why his conclusion might **not** be valid.

[3 marks]

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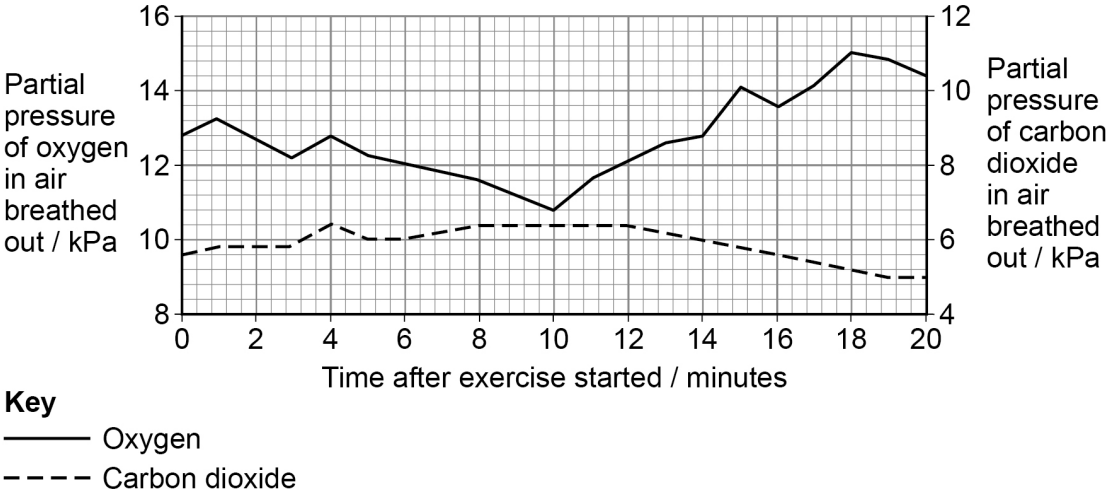
0 6 . 1 Describe the advantage of the Bohr effect during intense exercise.

[2 marks]

A cyclist completed a fitness test on an exercise bike. The intensity of the exercise was increased every 10 seconds. The test finished when he was unable to cycle any further. The partial pressure of oxygen (pO_2) and of carbon dioxide (pCO_2) in air breathed out was measured.

Figure 3 shows the results of the cyclist's fitness test.

Figure 3



Ventilatory threshold (VT) is a measure of the point when anaerobic respiration increases because aerobic respiration alone can no longer maintain muscle contraction.

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0 6 . 2 VT can be identified as the **first** point when there is an increase in pO_2 breathed out, without an equivalent increase in pCO_2 breathed out.

Use **Figure 3** to determine the **time** after the exercise started when the cyclist reached VT.

Calculate the **ratio** of pO_2 to pCO_2 in breathed-out air at this time.

Show your working.

[2 marks]

Time when the cyclist reached VT = _____ min

Ratio of pO_2 to pCO_2 at VT = _____:1

0 6 . 3 An increase in the intensity of exercise produces an increase in the volume of carbon dioxide produced.

However, **Figure 3** shows that the pCO_2 in air breathed out did **not** show a large increase during the exercise.

Suggest **one** physiological change that would cause this result. Explain how the physiological change would allow for the removal of the increase in the volume of carbon dioxide produced.

[2 marks]

Physiological change _____

_____

Explanation _____

_____

_____

_____

Question 6 continues on the next page

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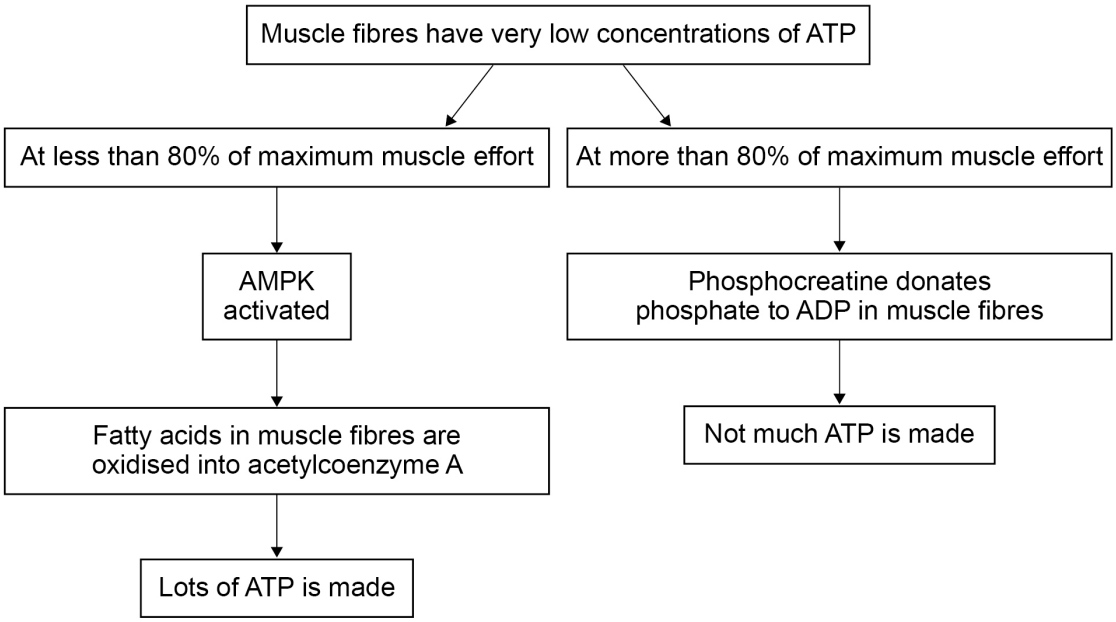
When muscle fibres have very low concentrations of ATP, they may get ATP in the following ways.

- AMPK (an enzyme) oxidises fatty acids.
- Phosphocreatine donates phosphate to ADP in anaerobic conditions.

Figure 4 shows how these chemicals work.

Figure 4



0 6 . 4 At more than 80% of maximum muscle effort, ATP can only be made for a limited time.

Use **Figure 4** to suggest **one** reason why.

Tick (✓) the correct box.

[1 mark]

ATP cannot move into muscle fibres at a fast-enough rate. ☐

Muscle fibres have a limited amount of phosphocreatine. ☐

Muscle fibres produce too much lactate. ☐

Muscle fibres quickly run out of ADP. ☐

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0 6 . 5 GW1516 is a performance-enhancing drug. GW1516 activates AMPK **and** develops slow muscle fibres at rest.

Use **Figure 4** to justify why professional athletes are **not** allowed to take GW1516.

Do **not** include details of chemiosmotic theory in your answer.

[4 marks]

Question 6 continues on the next page

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EPO is another performance-enhancing drug. It can increase the haematocrit (the percentage of red blood cells in blood).

0 6 . 6 A heart attack is caused by a lack of glucose and oxygen being delivered to cardiac muscle via the coronary arteries. The overuse of EPO can increase the risk of a heart attack.

Suggest how.

[2 marks]

0 6 . 7 The normal haematocrit for human males is 47(±5)%. For professional male cyclists, the maximum haematocrit allowed is 50%.

A student suggested that professional male cyclists should be allowed to use EPO until their haematocrit is 50%.

Give **two** reasons why this suggestion is **not** valid.

[2 marks]

1

2

15

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Section B

Answer **one** question.

You are advised to spend no more than 45 minutes on this section.

0 7 Write an essay on **one** of the topics below.

Either

0 7 . 1 The functions of enzymes and their importance in organisms.

[25 marks]

or

0 7 . 2 The causes and importance of variation and diversity in organisms.

[25 marks]

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END OF QUESTIONS

25

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